Relationship between some anthropometric, biomechanics and motor abilities on reactive strength for volleyball players

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Introduction:

Athletes get ready to reach their goals by concentrating on organized training, so the aim of training is to increase athlete's skills and his ability to improve his athletic performance. The success of training program depends on achieving its related aims. Assessment process (by testing and measuring) is the way to collect information by which we can take assessment decisions for the following performances and then the evaluation. (12)

The motor abilities help the athlete to improve all of his movement potentials to reach the peak of performance throughout the competitive phase and knowing the traits of anthropometric measurements for the athlete, which help in knowing the traits of the physical growth and monitoring it.(2:99)(8:88)

The reactive strength is defined as the ability of the musculotendinous unit to produce the biggest amount of strength, because of rapid transition from an eccentric muscle contraction to a concentric muscle contraction and usually the reactive strength exercises is referred as a plyometric exercise, which is known in Russian expression as shocking training. The plyometric training is one of the methods of jumping trainings which depends on shocking musculotendinous unit throughout the phase of concentric muscle contraction to achieve the fastest possible contraction as in the exercises of (deep jump and drop landing from different heights). (14) (18)

The reactive strength index (RSI) has been identified in previous studies as a metric unit that can be used to evaluate an athlete's reactive strength. Reactive strength is the ability to rapidly and effectively transition from an eccentric to a concentric muscle contraction within an SSC movement. (15)

Plyometric features, which are categorized based on the stretching and shortening cycle, are present in the majority of sports motions, including running, jumping, and change of direction. As an example, sprinting, landing actions from the box followed by jumping action and repeated broad jump in a period of time less than 250 milliseconds, and then slow motions that need more than 250 milliseconds till contacting the ground, like changing of direction actions and depth jumps. (10)

The movements that require explosive force or reactive strength differ because they are affected by many factors such as anthropometric and morphological variables, chronological age and the player's

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experience during his strength trainings.(16)

The athletes' movements are the only result for the interference of many factors, owning the motor abilities- such as strength, speed, agility, etc- and what combines it with what they own of the anthropometric body features and combining's which determine the quality of performance, not only that, but the regulated and monitored training processes for these factors resolve the performance to achieve the target and win the game.

The volleyball is one of the sports activities that is distinguished by rapid motor performance during attack and defense actions. Furthermore, this performance needs fast reaction and higher readiness after finished different skills to do another skill or even the readiness to face the opponent throughout the defensive processes, and rapid performance is built on integrating many motor abilities by strict training systems that allows reaching a high level of performance to reach the desired goals depending on player's morphological features and traits.

Jumping is one of the most critical performances in volleyball. For instance, jumping is a necessary component of many fundamental abilities for scoring points including serving, striking and blocking. Around 120,000 jumps are made by volleyball players during the training season, according to one study that involved 12 players, which reveals to us that jumping is critical for performance, and the importance of performing standardized training programs for volleyball players that allow them jumping in a way that is consistent with performance. (3:789) (5:975)

And from the researcher's experience in the sports training field, it has been found that coaches performed a lot of jumping exercises during the volleyball training process in an effort to increase performance. He also noticed a wide variety in the types and forms of jumping.

This led the researcher to determine the impact of some motor abilities and anthropometric measurements on the reactive strength when landing from different heights from a box of 50 cm and another of 30 cm trying to guide the training process, particularly in the activity of volleyball where the requirement for the player to have the reactive strength as one of the most important needed factors.

According to the nature of the activity, in trying to jump high after landing from a previous movement, whether it was to perform an offensive requirement or a defensive one. In addition, it is also important to accurately determine how much each player is impacted and whether they require more or fewer exercises to build their Reactive strength based on the anthropometric variables.

Research aim:

Determining how physical, biomechanical and anthropometric traits that affect volleyball players' abilities to reactive strength:

1. The relationship between some anthropometric traits and the reactive strength when landing from a box between 30 and 50 cm height.

2. The relationship between some motor abilities and biomechanical variables relating to the reactive strength when landing from a box between 30 and 50 cm height.

Research questions:

1. Is there a correlation between anthropometric factors and reactive strength when player lands from a 30 cm and 50 cm box height?
2. Is there a correlation between motor abilities and biomechanical variables on reactive strength when landing from a 30 cm and 50 cm box height?

Research procedures:

Research Methodology:

Descriptive method.

Research areas:

Domain spatial: Alexandria's Delphi Volleyball Club Hall.

Temporal domain: The study was conducted during the 2020–2021 training season, and the period of time covered by this investigation spanned from Sunday, January 3, 2020, through Sunday, January 10, 2020.

Subjects: volleyball player at Delphi Club, which competes in the Egyptian Premier League, 24 players were intentionally chosen from the first team.

Statistical analysis of the study's sample:

Table No (1)

Statistical description of the physical measurements of the research sample

Variables	Mean	Standard deviation	Min.	Max.	Skewness	Kurtosis
Mass	84.08	9.65	65.00	99.00	- 0.46	- 0.17
Height	1.90	0.09	1.70	2.03	- 0.74	0.80
Thigh length	49.17	4.31	42.00	57.00	0.15	- 0.83
tibia length	47.25	4.05	40.00	54.00	- 0.09	- 0.87
foot length	26.83	2.20	23.00	32.00	0.77	1.23
BMI	23.19	1.47	20.45	26.59	0.43	1.41
Age	22.83	4.98	18.00	31.00	0.65	- 1.12

Tools and means of data collection:

Anthropometric measurements:

1- An anthropometer to measure length to the nearest centimeter.

2- A medical scale calibrated to measure weight to the nearest kilogram.

3- A metric tape for measuring lengths (thigh, tibia, foot).

4- Body mass index (weight divided by the square of height).

Physical abilities tests:

8 physical tests were selected:

1- Broad jump test (BJ) (cm).

2- The vertical jump test (sargent) (VJ) (cm).

3- 3 steps vertical jump test (3SVJ) (cm).

4- The difference between the vertical jump test (sargent) and 3 steps vertical jump test. (D VJ AND 3SVJ) (cm).

5- Hit point height test (HPH). (cm).

6- The single leg triple hops with the right leg test (SLTH RL) (cm).
7- he single leg triple hops with the left leg test (SLTH LL) (cm).
8- T -test agility (sec).(6)
Biomechanical analysis and motion analysis using modern equipment and software:
Methods for measuring reactive strength

Equipment:

1- Wooden box 50 cm high.
2- Wooden box 30 cm high.
3- Sony action camera as-100 video camera with a frequency of 240 frames per second.
4- Camera tripod.
5- Computer (Pavilion dv6) type (hp) (Core TM i7).
6- A measuring bar (1 meter) to determine the scale of calibration.

How to perform the test:

After warming up, the player stands upright on the edge of the box, lifts one foot in the air, then places the other foot next to it without pushing, achieving the stage of landing from the box. Once the player touches the ground, immediately pushes the ground to achieve the highest jump, as well (Figure 1).

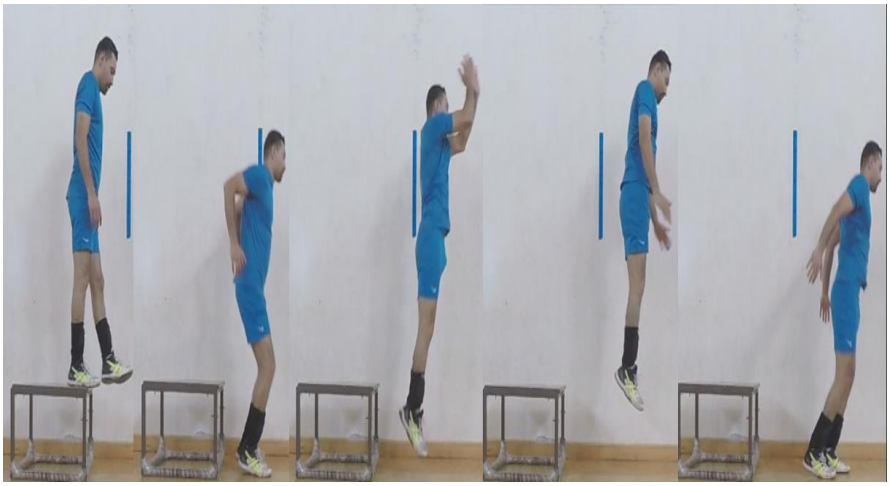

Figure No. (1) shows how to perform the "Reactive strength" test.

Method of calculating the score:

1- Each player has a valid attempt, and it is repeated when an error occurs.
2- The biomechanical variables (contact time and jump height) are extracted through the kinetic analysis program “Kinovea 0.8.2”.
3- Reactive strength" test is extracted through the following equation:
RS = jump height (m) / Ground contact time (sec) .(11)

Statistical Analysis:

Statistical treatments were performed using SPSS Version 25 at a confidence level of (0.95), corresponding to a significance level (probability of error) of 0.05:
Results:

Table No (2)
Statistical description of the motor abilities measurements of the research sample

Variables	Mean	Standard deviation	Min.	Max.	Skewness	Kurtosis
BJ	2.35	0.17	1.98	2.60	- 0.41	- 0.72
VJ	61.17	6.57	45.00	75.00	- 0.25	0.88
3SVJ	69.96	7.88	51.00	84.00	- 0.34	- 0.02
D VJ AND 3SVJ	8.79	3.78	4.00	19.00	1.32	1.66
HPH	3.06	0.12	2.79	3.26	- 0.49	- 0.05
SLTH RL	6.73	0.81	5.00	7.95	- 0.59	- 0.36
SLTH LL	6.37	0.57	5.20	7.25	- 0.32	- 0.42
T -test agility	7.23	0.36	6.48	7.85	- 0.02	- 0.30

Table No. (3)
Statistical description of the measurements of biomechanical variables for the research sample

Variables	Mean	Standard deviation	Min.	Max.	Skewness	Kurtosis
Contact time(s) 50-	0.29	0.04	0.20	0.38	- 0.03	- 0.02
(cm) 50 -Jump height	0.52	0.08	0.31	0.65	- 0.56	0.87
RS-50	1.80	0.41	1.07	2.85	0.54	0.71
(s) 30-Contact time	0.30	0.05	0.21	0.40	0.38	- 0.70
(cm) 30-Jump height	0.49	0.08	0.30	0.64	- 0.54	0.71
RS-30	1.69	0.37	1.06	2.48	0.27	- 0.43

The relationship between basic research variables and reactive strength:

First: The relationship between some anthropometric variables and reactive strength with 30 cm box

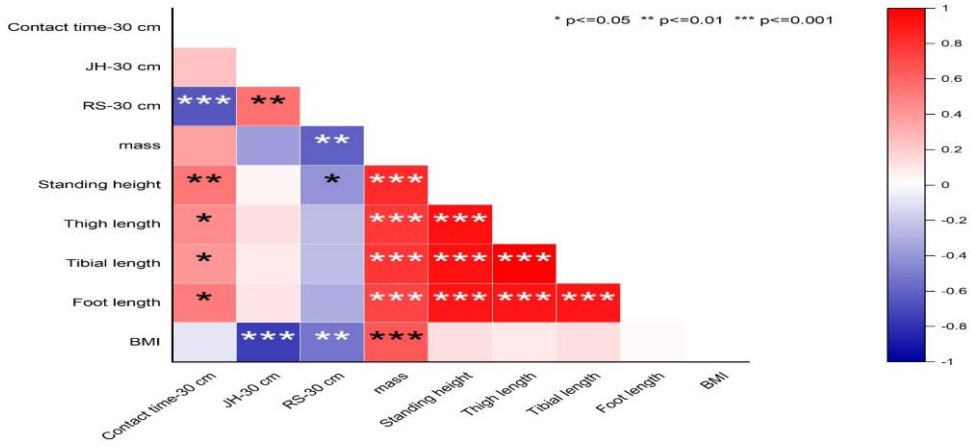

Figure 2. shows the relationship between the anthropometric variables and the reactive strength from a 30 cm high box.

There is a negative correlation between Weight and BMI index ($p < 0.01$) and there is a negative correlation between the reactive strength and the height ($p < 0.05$).

Second: The relationship between some motor abilities, biomechanical variables, and reactive strength with a 30 cm box

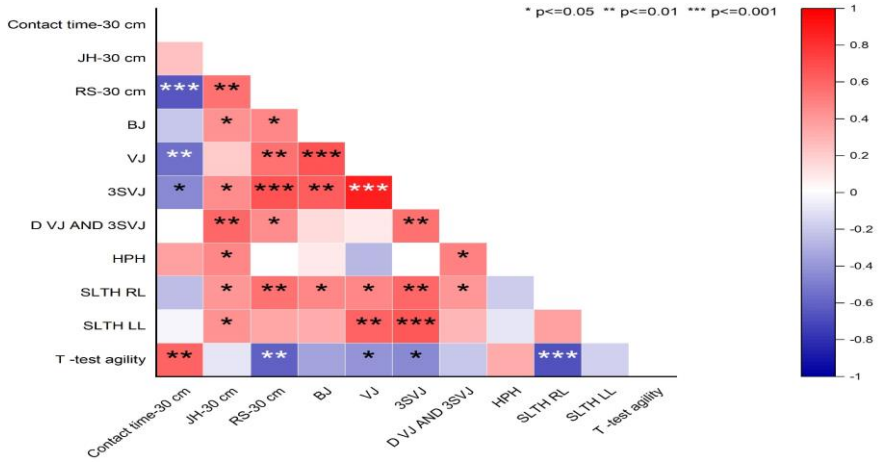

Figure 3. shows the relationship between motor abilities and biomechanical variables and the reactive strength from a 30 cm box height.

There is a correlation between some motor abilities, biomechanical factors and reactive strength from a 30 cm box, as seen in Figure 3:

There is a positive correlation between each of (the vertical jump test (sargent), the jump height, the single leg triple hops with the right leg test) and the reactive strength ($p < 0.01$).

There is a positive correlation between each of (broad jump test, The difference between the vertical jump test (sargent) and 3 steps vertical jump test) and the reactive strength (p< 0.05). There is a negative correlation between contact time and reactive strength (p< 0.001). There is a negative correlation between agility test and reactive strength (p< 0.01).

Third: the relationship between some anthropometric variables and reactive strength with the 50 cm box

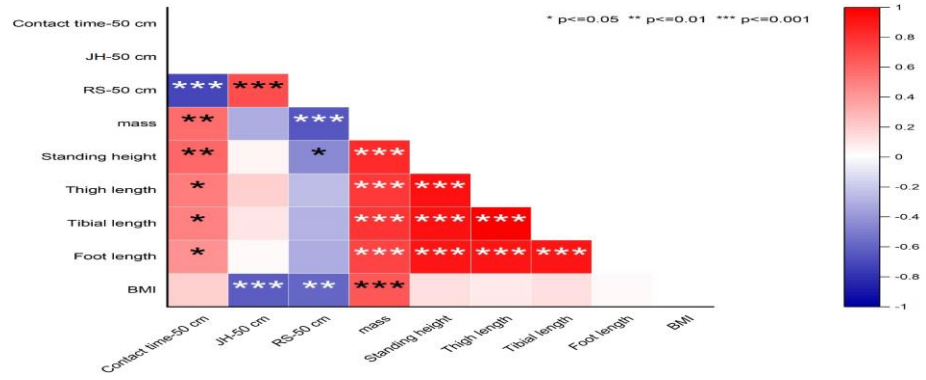

Figure 4. shows the relationship between the anthropometric variables and the reactive strength from a 50 cm box.

There is a negative correlation between the mass and the reactive strength (p< 0.001)

There is a negative correlation between the BMI and the reactive strength (p< 0.01)

There is a negative correlation between the height and the reactive strength (p< 0.05)

Fourth: The relationship between some motor abilities, biomechanical variables, and reactive strength with a 50 cm box

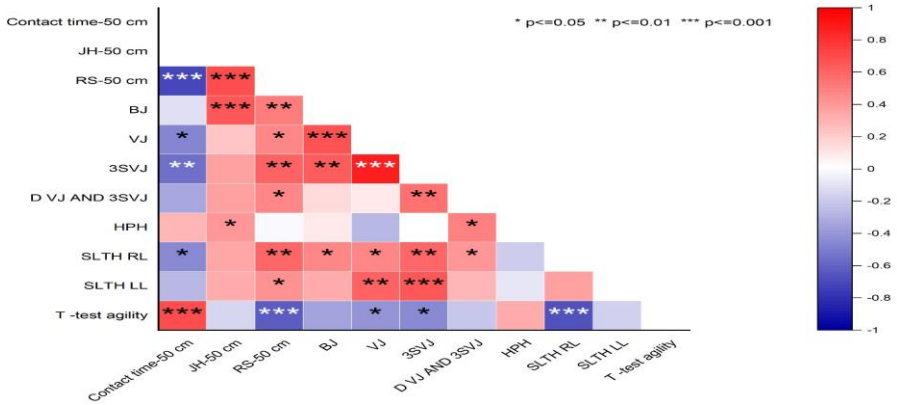

Figure (5) shows the relationship between motor abilities and biomechanical variables and the reactive strength from a 50 cm box height.

There is a correlation between some motor abilities, biomechanical factors, and reactive strength from a 50 cm box, as seen in Figure 5:

There is a positive correlation between the jump height and the reactive strength ($p< 0.001$).

- There is a positive correlation between each of (broad jump test, 3 steps vertical jump test, the single leg triple hops with the right leg test) and the reactive strength ($p< 0.01$).
- There is a positive correlation between each of (the vertical jump test (sargent), The difference between the vertical jump test (sargent) and 3 steps vertical jump test, the single leg triple hops with the left leg test) and the reactive strength ($p< 0.05$).

There is a negative correlation between (contact time and agility test) and the reactive strength ($p< 0.001$).

Discussion:

Figures (2) and (4) show that there is a negative correlation between weight and body mass index at significant value 0.01 with the reactive strength during the landing from a box of 30 cm, but there is a strong negative correlation at significant value 0.001 when landing from a box with a height of 50 cm, it should be observed that the increase in weight and body mass had a negative impact on the reactive strength, even though there is a negative correlation between the body mass index and the reactive strength at significant value 0.01.

And there we should mention the negative effect of body mass on the reactive strength Whereas the jumping that is used after landing from a box, regardless of its height (whether 30 or 50 cm) when the player's mass decreases the effect of the gravity decreases.

And that means there is a negative effect on the volleyball player, especially when the player lands from a different height. For that we should monitor the player's weight daily and continuously, and when player has more mass than his teammate, he should use a lower height especially when trains on reactive strength exercises.

Figures (2) and (4) shows that there is a negative correlation between height and reactive strength when a player lands from a box with a height of 30, 50 cm at significant value 0.05, and that means it's important to give the taller player more exercises on reactive strength using the plyometric method and it's the perfect way to improve the reactive strength like what we said before, this confirms that the player who has a taller leg spend more time through the reactive strength tests, so they should do exercises of reactive strength consistently to keep and improve their jump levels (13), because tall players with long legs take more time to complete the reactive strength tests, so we should concentrate on tall players to keep improving their jumping abilities so they can complete the volleyball activity's tasks.

Figures (3) and (5) shows that there is a negative correlation between both agilities, contact time and landing from boxes (30 and 50 cm high), there is a strong correlation for contact time at both heights and for the agility test there was strong correlation when landing from a box 50 cm high and a

medium correlation for the agility test when landing from a box 30 cm high.

We should mention that players with higher levels of reactive strength have better ability in movement that requires changing in direction and it increases their performance especially in volleyball tasks. Players with the attributes of reactive strength can perform better in their moving performance and movement with change of direction which is considered one of the most requirements in agility.

Additionally, it supports and agreed with Martnez et al., who demonstrated a substantial positive correlation between RSI and agility .(13)

Additionally, when using heights of 30, 50 cm, the reactive strength is influenced by the time of contact and the height of the jump, where the various heights contribute to and influence this motor ability because of the variations in landing times due to the mass of the player, so the less the contact time is, this indicates a greater force. Figures (3)and(5) indicates for the negative correlation.

This supports what Jarvis et al. and Beattie have said (1) (7). Additionally, the contact duration variable is a very important component in determining the reactive strength production and it is also a crucial factor during the evaluation process. According to Torres et al., evaluating volleyball player drop jump (DJ) performance characteristics (jump height, contact duration, and reactive strength index) was crucial.(17)

Figures (3) and (5) show that there is a medium positive correlation between the vertical jump test (sargent) and the height of the jump(after landing), the single leg triple hops test with the right leg and there is strong positive correlation in 3 steps vertical jump test and week positive correlation in broad jump test and also between the vertical jump test and 3 steps vertical jump test after landing from 30 cm box there is a week positive correlation but for the 50 cm box there is a strong positive correlation with the jump height after landing and a medium positive correlation with 3 steps vertical jump test, the broad jump test and the single leg triple hops test with the right leg and week positive correlation the vertical jump test (sargent) and the deference between the 3 steps vertical jump test and the vertical jump test and the single leg triple hops test with the left leg

And that shows that the difference in heights during the landing process affect the other variables of the reactive strength. The improvement of the reactive strength is one of the factors affecting the height of the jump and the development of strength correctly, these tests demonstrate the muscular capability of the muscles in the two legs. Particularly with regard the explosive strength, which improving performance, especially volleyball, and that agrees with ebben. Others said that the RSI provides a very accurate way to measure the explosiveness acquired through various plyometric workouts (4). According to Kipp et al. RSI explosiveness movement are related, and it is a

reliable indicator of lower body explosiveness strength.(9)

We should pay attention to understand the level of reactive strength especially in volleyball, which considered one of the main factors to achieve a high level of jumping movements, to increase the efficiency to reach the ball quickly, which is important to do offensive or defensive tasks, because the reactive strength contributes to the requirement for skillful performance.

And volleyball players who have the reactive strength characteristics enable them to change their direction to reach the ball, especially when they are trying to block the ball during defense performance. It should be clear to coaches the importance of the reactive strength and how the reactive strength affects the performance. So, it's recommended to develop it, in order to accomplish the desired result.

Conclusions:

1. There is a negative correlation between both weight and height on reactive strength during landing from a box of 30, 50 cm. When the mass and height increases the more negatively it affects the reactive strength.

2. As the reactive strength increases, the more skillful performance during the agility test increases, whether during the landing from a height of 30 or 50 cm.

3. The reactive strength from a box of 30 cm affects the muscular strength of the two legs for the vertical jump test (sargent) and the jumping after 3 steps.

4. The contact time is affected by the landing from a different height, so it decreases for lower heights of 30 cm and increases for higher heights of 50 cm.

Recommendations:

1. Coaches should pay attention to monitoring and maintaining volleyball players' weights and body mass indexes, for its result in improving performance.

2. Focusing on increasing reactive strength for volleyball players which helps in increasing agility.

3. Focusing on explosive strength workouts with a 30 cm height is recommended, because it has a good impact on jumping high.

4. Focusing on speeding movements after landing from a box, especially the height of 30 cm to increase the reactive strength.

5. Should be doing more research in different box heights and sports especially the sports allowing change of direction movement and jump heights

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